

**Before The
FEDERAL COMMUNICATIONS COMMISSION
Washington, D.C. 20554**

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In The Matter Of)	
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Unlicensed Operation in the TV Broadcast Bands)	ET Docket No. 04-186
)	
Additional Spectrum for Unlicensed Devices)	ET Docket No. 02-380
Below 900 MHz and in the 3 GHz Band)	
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To: The Commission

Reply Comments of Charles L. Jackson and Dorothy Robyn

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I. INTRODUCTION

The Commission's Further Notice of Proposed Rulemaking (FNPRM) formally expanded this proceeding to include consideration of a licensed approach to use of the TV white space—a welcome development. In our January 31 Comments, we sought to better define this licensed option and to evaluate its economic benefits relative to those of unlicensed access. We concluded that a licensed approach—*i.e.*, an FCC auction of flexible, tradable rights to the use of the white space—would be superior to an unlicensed approach in three key respects.

Economic Efficiency: Licensed access would create both the incentive and the opportunity for white-space licensees and broadcasters to engage in negotiations to expand licensed service. Such negotiations (what economists refer to as “Coasian bargaining,” after Nobel Laureate Ronald Coase) would allow spectrum users to improve on the starting point defined by FCC interference standards to achieve a more efficient use of the white space.¹ Moreover, the FCC's standards themselves would most likely be less protective in a licensed regime, because of the advantages that licensing offers with respect to interference control—and that too would free up white space for use by licensees.

Our calculation of the amount of white space that would be available under alternative scenarios provides a measure of the second effect. Under interference-protection rules appropriate to a licensed regime, 97 percent of the population lives in locations at which there will be at least 24 MHz of spectrum available in the white space following the DTV transition. However, under interference-protection rules that correspond to those the FCC is most likely to impose in an unlicensed regime, there would be dramatically less (about half as much) spectrum available in the white space.

Incentives for Investment: The incentives for investment in white space systems would be far weaker in an unlicensed regime compared to a licensed one—a second major argument for licensing. For short-range data transfer, unlicensed TV spectrum would be inferior to the existing unlicensed bands at 2.4 GHz and 5 GHz. A combination of limited data rates, network externalities, and the added costs to avoid interference with incumbents would impede adoption of this band for the market needs served by today's wireless local area networks (LANs). Similar factors fatally impaired the unlicensed PCS (UPCS) band. Although unlicensed white space (unlike UPCS) would attract users, the likely short-range applications would not add significant value beyond those found in existing unlicensed bands today.

Investment in long-range applications in the white space would be impeded for a different reason—the threat of interference, primarily from short-range wireless LAN operations in that spectrum. (More generally, unlicensed spectrum is a poor home for long-range services because of the tendency for short-range services to crowd them out.) Long-range systems typically

¹ In plain language, white-space licensees would be able to engineer-in their systems much more closely to the broadcasters' Grade B contour than would otherwise be possible, thereby generating valuable additional capacity. For example, the broadcaster might agree to accept additional interference or the white-space licensee might arrange for interference control measures at consumer premises. Such interference control measures could include improved antenna systems or smart antennas at the consumer's premises.

require significant infrastructure and corresponding investment. Unlicensed operation provides no protection from interference from competitors or consumer-owned devices. The risks of interference raise the cost of capital for such systems and reduce the level of investment.

By contrast, licensed access, by controlling interference, provides better incentives for the provision of long-range services such as wireless Internet access, for which this spectrum is particularly well-suited. Thus, a licensed approach is far more likely to produce the large investments in long-range infrastructure that rural broadband requires.

The FCC's ongoing 3.65 GHz proceeding supports the view that lack of exclusive rights discourages investment in long-range infrastructure; the FCC's contention-based access rules face opposition from a variety of interests that want to provide long-range service or equipment for long-range services in that spectrum.

Long-Term Evolution of the TV Band: Perhaps the key advantage of licensing is that it would put in place a mechanism whereby the TV bands could transition to more productive uses (the process referred to as “the Negroponte Switch”). If broadcasters were given flexible use rights, over time, broadcasters and white-space licensees would reengineer the broadcast system, freeing up most of the spectrum for higher value applications. In sharp contrast, unlicensed access would impede the long-term transition of the TV band to higher value uses by creating a constituency of spectrum “squatters” and their suppliers. In this way, an unlicensed regime would perpetuate the signal flaw in the current regulatory system—its tendency to encourage rent-seeking and discourage entrepreneurial innovation. In principle, one could use technology to moderate the effects of the squatter's rights problem. But it would require political will to impose a technological solution—an unlikely scenario.

Structure of this Document

In this document, we reply to the Comments submitted by the two major sets of proponents of unlicensed white space: the New America Foundation and a group of self-styled consumer and non-profit groups (“NAF, *et al.*”); and a coalition of U.S. equipment manufacturers and technology firms, including Dell, Google, Hewlett Packard, Intel, Microsoft and Philips. We respond primarily to their arguments regarding impediments to the deployment of licensed services in the white space (Section II). We also comment on their assertion that a presumed advantage of allowing licensed as opposed to unlicensed operations in the white space—the ability to control harmful interference—has been overstated (Section III). Finally, we address two points in NAF, *et al.*'s discussion (largely a recapitulation) of the economic benefits of unlicensed white space (Section IV).

II. POTENTIAL IMPEDIMENTS TO LICENSED USE OF TV WHITE SPACE

Unlicensed proponents maintain that the TV white space is ill-suited to the deployment of licensed services. The alleged impediments to licensed use of the white space are discussed in three separate sets of Comments, which vary in terms of their scope.² Although the discussions do not directly contradict one another, the differences in scope are revealing.

A. Auxiliary Users (Wireless Microphones)

The NAF, *et al.*'s Technical Comments—unlike their non-technical Comments—are co-authored by a group of highly respected engineers and technologists. Over the last 18 months, several of these technical experts have challenged the broadcasters' claim that unlicensed use of the white space would cause harmful interference. Their Technical Comments deal largely with issues related to interference detection and emissions.

In addition, the Technical Comments include a discussion of "Obstacles to Exclusive Licensing." The discussion focuses entirely on auxiliary users of the TV band—essentially, wireless microphone systems. Unlike broadcast stations, which are relatively stationary, these auxiliary users are not limited to a fixed transmitter location or frequency. The technical experts argue that successful licensing and auctioning of the TV white space is not practical unless the auxiliary users are either relocated to other spectrum or subordinated to the new, white-space licensees.

We offer four observations on the Technical Comments. First, we note the very narrow scope of the technologists' discussion of "Obstacles to Exclusive Licensing." As described below, the non-technical Comments submitted by NAF, *et al.* and the manufacturers' coalition cite a litany of impediments to licensed use of the white space, of which wireless microphones are only one. The fact that the Technical Comments focus exclusively on wireless microphones suggests that the technical experts may not see the other issues as serious impediments to the licensing and auctioning of TV white space.

Second, the substantive view that the technical experts express is not inconsistent with our own: the presence of wireless microphones would be a complicating factor in a licensed white space regime, and the FCC should adopt a transition plan for moving these users to more appropriate spectrum over time. In our January 31 Comments, we suggested several approaches that would protect the current investment in wireless microphones during the transition—albeit at some cost to the capacity and/or efficiency of the licensed systems operating in the white space. In the Appendix to this document, we propose a more detailed transition plan.

Simply stated, it should be no more difficult or controversial to transition wireless microphones from the white space than it was to relocate licensed incumbents in other spectrum bands where

² Comments of NAF, *et al.* in ET Docket 04-186 (February 1, 2007); Technical Comments of NAF, *et al.* in ET Docket 04-186 (February 1, 2007); and Comments of Dell, *et al.* in ET Docket 04-186 (January 31, 2007).

such relocation allowed for more valuable use of the spectrum.³ The relocation of wireless incumbents is old hat to the Commission and should not represent a major impediment to the licensing of the white space.

Third, we observed in our Comments that wireless microphones would be a problem as well for unlicensed operations in the white space, and the views expressed by the technical experts are consistent with that observation (the Technical Comments include a discussion of wireless microphone issues for unlicensed TV band devices). But whereas the parties would be able to negotiate and make side-payments to resolve the problem in a licensed regime, an unlicensed regime would preclude such agreements. Under our notional transition plan, as described in the Appendix, wireless microphone operators would be able to pay the white-space licensee for continued use of the spectrum. Such an efficiency-enhancing arrangement would be altogether impossible in an unlicensed, open-entry regime.

Finally, we note the technical discussion regarding the need for wireless microphones to face the appropriate spectrum-use incentives. The Technical Comments observe that, although (legal) wireless microphones are “licensed,” the lack of frequency assignment and location means that they operate more like unlicensed devices under current arrangements. NAF’s technical experts maintain that requiring wireless microphones transition to an arrangement under which they have to pay for their spectrum rights would achieve “better long-term spectrum utilization”:

Would [requiring wireless microphones to pay for their spectrum] cost more than the current systems? Of course! *Free licensed spectrum with economic externalities usually results in lower direct costs to users than spectrum use based on marketplace forces*—which the Commission favors in most non-public safety applications except in cases where an unlicensed “commons model” is justified. But such an approach would result in better long-term spectrum utilization.⁴

We agree with the reasoning of NAF’s technical experts. This is the very logic that leads us to argue that the rights to the TV white space should be licensed and auctioned, not provided on an unlicensed basis with user access rationed by congestion.⁵

³ For example, microwave incumbents had to be moved off the 1.9 GHz spectrum to make way for PCS licensees; currently, federal users and private microwave incumbents are being relocated off the 1.7 and 2.1 GHz spectrum to give way to the new AWS licensees.

⁴ Technical Comments of NAF, *et al.*, pp. 20-21; footnote omitted; emphasis in the original.

⁵ In their Technical Comments, NAF, *et al.* also make the equity case for requiring wireless microphone operators, many of whom are linked to well-heeled broadcasters, to pay for their spectrum. They refer to the controversy surrounding Clarity Media, the operator of Flying J truck stops, which has applied for an experimental FCC license to sell TV service to truckers who park their rigs at a Flying J facility. NAF, *et al.* quote a broadcasting official who was recently asked about the industry’s opposition to the application: “[Clarity] is a multibillion dollar company. It is not clear at all to me why they couldn’t buy spectrum at auction (or) use the unlicensed bands.” NAF, *et al.* go on to ask why wireless microphone operators shouldn’t be required to do the same. We would pose that same question with respect to Intel, Microsoft and the other multi-billion dollar, global technology companies that have teamed up with NAF, *et al.* to secure the white space at no cost: why should the federal government not require these firms to buy the spectrum at auction or else use the existing unlicensed bands?

B. Other Potential Impediments

As mentioned above, the non-technical Comments submitted by unlicensed advocates—documents that were not co-authored by the technical experts—identify a much longer list of impediments to the deployment of licensed TV band devices. Some of the impediments reflect the geographically discontinuous character of the TV band (“Swiss cheese”); others relate to uncertainties about who will use the TV band and how (and where) they will use it. These uncertainties include the unsettled nature of spectrum allotments for low power TV stations and TV translator stations; ongoing or anticipated efforts by broadcasters to expand their interference protection rights and modify their DTV licenses; and the presence of non-stationary wireless microphones, as discussed above. The unlicensed proponents conclude that “uncertainty about [spectrum] rights and licensing don’t mix well, and the extent of uncertainty in this band for a bidder is huge.”⁶

In our January 31 Comments, we addressed at length the argument that the Swiss-cheese nature of the TV band would make licensing prohibitively complex or costly (*i.e.*, high transaction costs). We offered two broad insights. First, transaction costs arise only if licensed usages of the white space create spectrum opportunities that would not exist in an unlicensed regime.

An assessment of [the “Swiss cheese”] arguments should start with a simple point that often gets overlooked: transaction costs are an issue only because licensed operations would make more extensive and efficient use of the white space than unlicensed operations. A white-space licensee could always eliminate (or significantly reduce) transaction costs by using the white space in the same way that unlicensed advocates propose—namely, with low-power devices and rule-based sharing protocols. Consumers would be no worse off under that scenario than under an unlicensed scenario; in fact, they would probably be better off because broadcasters might well tolerate less protective FCC interference standards in a licensed regime, as we discussed earlier.⁷

In sum, in this context, transaction costs should be seen as a positive indication of spectrum utilization. A white space licensee will reach an agreement with a broadcaster for the broadcaster to accept more interference only if the benefits of that agreement exceed the costs to the licensee. Those benefits, together with the any payment to the broadcaster, represent the efficiency gain from Coasian bargaining.

Second, contrary to the claims of unlicensed advocates, the transactions and coordination necessary in a licensed environment need not be prohibitively complex or costly. The FCC typically structures overlay licenses with an eye to limiting coordination costs, and structuring licenses for the white space would not be fundamentally different.⁸

With respect to the second set of impediments—uncertainties about who will use the white space and how—we offer two additional observations. First, here, as in many other spectrum policy contexts, policymakers must decide what the rules will be—*i.e.*, determine what rights to

⁶ Comments of NAF, *et al.*, p. 47.

⁷ Comments of Charles L. Jackson and Dorothy Robyn in ET Docket 04-186 (January 31, 2007), p. 52.

⁸ *Ibid.*, pp. 52-53.

transmit and what protection from interference each licensee will have. If such rules are well designed, they will eliminate many of the uncertainties that unlicensed advocates identify. For example, the FCC could modify its rule to prohibit the authorization of new TV translators within 50 miles of the geographic center of the 100 largest cities after a specified date (say, January 1, 2010). Such a rule would have little adverse impact on translator licensing—all of the translators needed to cover such close-in locations have probably been licensed already—but it would reduce uncertainty for white-space licensees.

Second, to the extent that uncertainty remains, the market for spectrum licenses can and will factor that into the price of the licenses. Contrary to the claim of unlicensed proponents, there is nothing inconsistent about licensing and uncertainty about spectrum rights; the ability to handle uncertainty—and adjust the relevant price appropriately—is a signal strength of markets.

C. 700 MHz Guard Bands and the 900 MHz M-LMS Spectrum

In addition to identifying perceived impediments to licensed use of the white space, unlicensed proponents argue against licensing by way of analogy. Specifically, NAF, *et al.* cite two cases in which the FCC's use of exclusive licensing in "Swiss cheese spectrum" has resulted in failure: the 700 MHz Guard Bands and the multilateration Location and Monitoring Service (M-LMS) spectrum band at 902-928 MHz.⁹ These two examples are, indeed, instructive, but not in the way that NAF, *et al.* intend. In both cases, the FCC relied too little rather than too much on market forces. And in the M-LMS example, manufacturers and users of Part 15 unlicensed devices are themselves the heart of the problem; the case serves as a preview of how unlicensed white space devices would be likely to impede the evolution of the TV band to higher value uses.

700 MHz Guard Bands

The 700 MHz Guard Bands were established in the context of the Nextel-public safety conflict in the 800 MHz band, and in keeping with a statutory framework that assigned one portion of the 700 MHz band to public safety licensees and another to commercial licensees. The FCC created Guard Band Managers as a new class of commercial licensee that could make spectrum available to system operators and end users but whose primary responsibility was to ensure that commercial users did not interfere with public safety communications in the adjacent band. The Commission imposed a variety of restrictions on Guard Band Managers and Guard Band operations, some of which (e.g., no cellular architecture) were quite limiting. The Guard Band licenses were successfully auctioned off, but few systems have gone into operation, and Guard Band Managers have asked the FCC to modify the band plan and revise the service rules to stimulate use of the Guard Bands. NAF, *et al.* view the Guard Band policy as a failure, and they place the blame on the FCC's effort to wedge licensed services into "Swiss-cheese spectrum"—referring to the high level of concern about interference with (public safety) incumbents and the uncertainty surrounding the 700 MHz band in connection with the DTV transition. In their view, the Guard Bands were an ideal site for unlicensed operations, which they allege can adapt to an environment characterized by interference-sensitive incumbents and technological uncertainty.¹⁰

⁹ Comments of NAF, *et al.*, pp. 30-35.

¹⁰ NAF, *et al.* discuss the 700 MHz Guard Band example both because they see it as similar to the white space ("Swiss cheese") and because they assert that a decision to adopt a licensed service in the white

We take some issue with NAF, *et al.*'s starting assumption that the Guard Band policy has failed. Although few would argue that the policy has been a complete success, the primary goal of the policy was to protect public safety radio from interference, and that goal appears to have been achieved—albeit with a loss of efficiency that may have been unnecessarily high. Granted, the secondary goal—commercial utilization of the band—has not been met (although the jury is out to some degree because public safety and commercial uses of the 700 MHz band are still in their infancy). But it is questionable that unlicensed operations would have been substantially more successful under the same circumstances, and such operations would have created a greater risk of interference with public safety users.

If anything, the problems with the Guard Band policy reflect too little reliance on market forces rather than too much—contrary to what NAF, *et al.* suggest. For example, the restriction on licensee-band managers acting as service providers was an artificial constraint on the market. Alternatively, the FCC might have licensed the guard-band spectrum as part and parcel of the larger 700 MHz band but with a prohibition on licensee deployment of interfering systems.

That said, this was not a case in which the FCC could rely on Coasian bargaining—*i.e.*, assigning well-defined rights to spectrum users in adjacent spectrum bands—public safety and commercial—on the assumption that the parties would work out the optimum division of interference between the two bands through direct negotiation. Although such bargaining occurs on a regular basis in other parts of the spectrum, public safety users fragmented into tens of thousands of entities, and few of them have the expertise to negotiate over interference rights.

900 MHz M-LMS Spectrum

The story of the FCC's efforts to foster M-LMS service at 902-928 MHz—which we would agree have been a failure—really began in 1974, when the Commission established interim rules for an Automatic Vehicle Monitoring (AVM) service, partially in response to the recommendations of the 1968 National Advisory Commission on Civil Disorders (Kerner Report). The AVM rules, which contemplated the operation of two wide-band systems in separate subbands of the 902-928 MHz band, were designed to permit precision location of public safety vehicles; one goal was to be able to identify and dispatch the nearest public safety vehicle in response to officer-in-trouble reports and other requests for help. For a variety of reasons, including technological limitations and lack of funding, the AVM rules did not generate a widely used service, and in 1989 and 1990, the Commission allowed Part 15 unlicensed devices into the band as part of a broader change in policy. By the early 1990s, when AVM licensees petitioned the FCC to request a rule change so that they could provide cellular and other new services, the performance of their systems had been degraded by the presence of unlicensed devices. Although such devices were secondary to—and obligated not to interfere

space would require the FCC to recapitulate the same process. But the FCC is actively looking at possible ways to change the rules governing the Guard Bands. Thus, it seems highly unlikely that the FCC would adopt that same approach in the white space. For example, no one has suggested that white space licensees would only be permitted to lease the spectrum to third parties. Moreover, the FCC has other, positive precedents that it could follow, such as the type of overlay licenses that were issued in the Direct Broadcast Satellite (DBS) band.

with—AVM systems, that policy was not enforced (in practice, it may have been impossible to enforce).

The FCC’s AVM/LMS proceeding, which concluded in 1995, left licensees worse off, not better. The Commission rejected most of the licensees’ requests for new use of the spectrum because of the impact on unlicensed users.¹¹ The Commission adopted other restrictions as well to protect unlicensed users—restrictions that are still in place today. They include a “safe harbor” rule—unlicensed devices that complied with certain technical parameters could not be deemed to have caused harmful interference to M-LMS systems—and a requirement that M-LMS licensees had to demonstrate through field tests that their systems would not cause “unacceptable levels of interference to Part 15 devices.”

The final blow to M-LMS service came from GPS technology—an alternative approach to geolocation that offered many advantages and that became increasingly low-cost as GPS receivers disseminated rapidly. (A major catalyst was the Commission’s 1996 interim E-911 rules, which required CMRS carriers to meet standards for identifying the location of emergency callers.) Predictably, the M-LMS licenses, which were auctioned off in 1999 and 2001, sold for very low prices.¹² In 2002, the largest M-LMS licensee, Progeny, petitioned the FCC for greater flexibility to meet changing market conditions; among other things, it asked for relaxation of the safe harbor rule and the restriction on real-time interconnection with the public switched network. The FCC’s request for reactions to the Progeny petition “attracted a firestorm of comments, mostly from unlicensed manufacturers and their trade associations, who immediately recognized the harmful impact Progeny’s proposals would have, if implemented, on unlicensed operation.”¹³

Despite the opposition—and to the dismay of the unlicensed community—the FCC issued a Notice of Proposed Rulemaking on the Progeny petition just last year, and the proceeding is still underway.¹⁴ NAF and its allies strongly oppose Progeny’s petition on two grounds. First, they maintain that granting M-LMS licensees more than a trivial amount of additional spectrum flexibility will do serious harm to unlicensed service in the 902-928 MHz band. Second, they argue that if the M-LMS licensees succeed in getting the changes they seek, the FCC would be rewarding spectrum speculation and deliberate regulatory arbitrage. To prevent M-LMS licensees from “perpetually lobby[ing] for more government spectrum handouts,” NAF and its allies argue that the FCC should rescind their licenses altogether (the licensees have apparently not met their buildout requirements) and use the reclaimed spectrum to give unlicensed users greater flexibility.

Given the dominance of GPS technology, it is questionable that AVM and M-LMS would have succeeded even if the licensees had enjoyed the band all to themselves. The FCC nevertheless erred by, in effect, renting the same property to two different tenants. And what makes M-LMS particularly pertinent to the white space debate is that one of the tenants was unlicensed.

¹¹ Comments by NAF, *et al.* in ET Docket 06-49 (May 30, 2006), pp. 5, 16.

¹² *Ibid.*, p. 2. Progeny, the largest M-LMS licensee, reportedly paid \$2.36 million for 228 of the 528 licenses.

¹³ *Ibid.*, p. 6.

¹⁴ FCC, Notice of Proposed Rulemaking, ET Docket 06-49 (March 7, 2006).

The key lesson we draw is that, once the FCC opened the spectrum at 902-928 MHz band to unlicensed devices, it unleashed technical and political forces that made the decline (if not the demise) of licensed service in that band inevitable. In terms of the technology, it was predictable that the short-range unlicensed devices would eventually crowd out the longer-range licensed AVM/M-LMS systems.¹⁵ We observed in our January Comments that this same asymmetric interference scenario appears to be taking place today in the 2.4 Ghz and 5 GHz unlicensed bands.

Similarly, the decision to allow Part 15 devices set in motion a political dynamic destined to bring about the regulatory equivalent of crowding out. The Commission's 1995 decision on service rules, which NAF and its allies boastfully recount in a 2006 FCC filing, is a testament to the power of squatter's rights:

The FCC carefully designed M-LMS to be a niche service so it would make minimal use of the 902-928 MHz spectrum and therefore cause minimal interference with unlicensed service in that band. That was the very essence of the service. It would be geographically isolated; for example, it would help track stolen cars and provide other vehicle monitoring service in places, such as outdoors in the middle of streets, where unlicensed devices, such as cordless phones, were unlikely to be harmed. It would be time limited; for example, it wouldn't be allowed to connect to the public switched network because that would encourage the continuous use of spectrum (e.g., for conversations) rather than the intermittent use of spectrum (e.g., to periodically send vehicular location information). It would also be demand limited; for example, compared to other licensed services, there just wasn't that much spectrum needed to meet the demand for vehicle location and monitoring data.¹⁶

Predictably, Progeny's proposal to relax these rules and service restrictions generated a strong response from unlicensed manufacturers and users:¹⁷

Should the Commission lift the restrictions on the types of services that LMS operators may provide and eliminate the safe harbor provision, the resulting congestion in the 902-928 MHz band will be catastrophic to Part 15 users. (FreeWave Technologies)

[T]he real effect of [Progeny's proposal would be to reduce in half the size of the band where Part 15 devices could operate at all...[T]he effect of offering the LMS licenses the

¹⁵ When a short-range service, such as a wireless LAN or a cordless phone, receives interference from a long-range system, such as a wireless ISP, the range of the short-range system shrinks—the cordless phone may not work in the attic during times of interference. In contrast, when a short-range service interferes with a long-range service it creates coverage holes in the coverage area of the long-range services. For example, although Albert's wireless LAN may block wireless ISP service to his next-door neighbor Zelda, the wireless ISP serving Zelda has a minor impact on Albert's wireless LAN. See, for example, the comments of wireless ISP operator Maximum Access LLC discussed below.

¹⁶ Comments of the NAF, *et al.* in ET Docket 06-49 (May 30, 2006), p. 16. Most of the consumer and non-profit groups that signed on to these comments are also co-authors of NAF's filings in the white space proceeding.

¹⁷ The following are cited in *Ibid.*, p. 14.

flexibility Progeny requests would be to greatly increase the use of the band, ultimately destroying the ability of Part 15 devices to operate. (GE-Internlogix)

Progeny's requests for increased bandwidth and service and technical flexibility would translate into substantially different LMS operations, leading to considerable and potentially devastating interference created by LMS licensees to Part 15 users. (SchlumbergerSema)

Although one would normally take such dire predictions with a grain of salt, in this case, we are inclined to believe them for the simple reason supplied by NAF and its allies in their 2006 M-LMS filing: considering how tightly the FCC constrained M-LMS in 1995 in order to protect unlicensed users, any meaningful relaxation of those constraints would almost certainly harm that group of users—a group whose numbers have exploded in size since 1995.¹⁸ In short, more flexibility for licensed spectrum users inevitably means less flexibility for unlicensed users.

This phenomenon points up the second lesson we draw from M-LMS: at least in certain bands, the contest between licensed and unlicensed spectrum users is a zero-sum game. This runs directly contrary to the oft-heard claim that unlicensed users can co-exist peacefully with licensed users—for example, in an unlicensed underlay.¹⁹ Unlicensed advocates are now trying to take this zero-sum contest to its logical extreme in the M-LMS case by getting the licensees' spectrum reallocated for unlicensed use so as to prevent “more government spectrum handouts.” One need not be sympathetic to the licensees to see the irony in this.

In sum, the FCC's decision to allow unlicensed devices in the 902-928 MHz band effectively foreclosed other meaningful uses of the band: unlicensed users crowded out the licensed users at a technical level. Ultimately, they were able to finish the job through regulatory crowding out.

This is precisely what we fear would happen in the white space. As a technical matter, short-range unlicensed systems would be likely to crowd out longer range licensed systems for the reasons we described. Regulatory crowding would be no less likely; the Part 15 manufacturers and users in the 900 MHz band have given us a preview of how it would work. As unlicensed devices expand in number, the relationship between unlicensed and licensed services will become a zero-sum game, in which more for licensed users means less for unlicensed. Eventually, unlicensed users and manufacturers will insist on having the entire TV band to themselves.

¹⁸ *Ibid.*, p. 16. NAF and its allies estimate that there could be as many as 100 million Part 15 devices operating at 902-928 MHz.

¹⁹ The politics surrounding unlicensed spectrum usage were illustrated this week by a news story about the impact of a military VHF land-mobile radio system on garage door openers. That story described how interference from a new radio system at the Marine base interfered with garage door openers. Although, the unlicensed garage door openers are secondary users of the spectrum, and under the law must accept any interference, the users of those systems were not very understanding. Said one victim of the interference, “I feel there should be some kind of compensation—I am a struggling widow, if you will, and I praise the Lord I'm still here, but I am on a budget.” “Near Quantico, A Click, but Garage Door Doesn't Budge,” *Washington Post* (February 26, 2007).

III. LICENSED WHITE SPACE OPERATIONS AND INTERFERENCE

Unlicensed proponents maintain that the FNPRM overstates the benefits of a licensed regime in the TV white space. In particular, they dispute the presumption that licensing would be a superior way to minimize harmful interference. Our January 31 Comments did not address the relative benefits of the two approaches—licensed versus unlicensed—in terms of interference prevention.²⁰ Nevertheless, we cannot let this claim by unlicensed advocates go unaddressed.

Dell, *et al.* challenge in particular the conventional notion that “interfering licensed uses will be easier to shut off.”²¹ But their logic flies in the face of a century of spectrum management experience.

One of the key purposes of licenses and call signs is to facilitate the tracking down of interference. Every day, co-channel wireless carriers work with one another to control interference between their systems. Consider a viewer located at First and Main Streets who reports interference to her local broadcaster. In a licensed environment, the broadcaster can look in the FCC’s database and determine who the white space licensee is; depending on the service rules that the FCC adopts, the broadcaster may even be able to see where the white space licensee’s transmitters are located. Alternatively, the TV station could call up the white space licensee and ask, “Hey, are you guys doing anything new over near First and Main? We have a report of interference there.”

Contrast that with an unlicensed environment. In response to a call from the viewer at First and Main, the broadcaster can ask the FCC’s Enforcement Bureau to track down the interference; but the FCC would face a near impossible task—especially if the interference is caused by a mobile device, which moves around constantly. Alternatively, the broadcaster can try to track down the source of interference itself, which would require sending out a team of technicians equipped with the appropriate measurement devices—an expensive proposition.

In sum, the licensed regime provides multiple mechanisms to control interference that do not exist in the unlicensed regime. Furthermore, licensees have stronger incentives to limit interference than do unlicensed users.

²⁰ Our January 31 Comments focused on the relative economic benefits of licensed versus unlicensed access to the white space in the belief that spectrum allocation is, ultimately, an economic policy choice. We ignored the technical question of whether an unlicensed approach would create harmful interference on the assumption that the FCC could find a way to implement such an approach that would control interference. And we assumed that a licensed approach, by its very nature, would control interference. Comments of Charles L. Jackson and Dorothy Robyn, p. 1.

²¹ Comments of Dell, *et al.* in ET Docket 04-186 (January 31, 2007), p. 25. The manufacturers also challenge the claim that “unlicensed users will have greater incentive to interfere.” We know of no one who has asserted that either unlicensed users or licensed users have any positive incentive to interfere. Rather, the concern is the incentives to avoid interference. We think it is self evident that licensed operators, who are subject to FCC sanctions and are generally familiar with the basic problems of interference, have far stronger incentive and ability to avoid interference than do unlicensed end-users.

NAF, *et al.* point to the Nextel-public safety conflict at 800 MHz as evidence that licensing does not necessarily suffice to control interference. But that situation was unique, as the FCC has stated:

The Commission found it necessary to re-band the 800 MHz band to resolve ... “near/far” interference, which, in that band, was ‘caused by a fundamentally incompatible mix of two types of communications systems: cellular-architecture multi-cell systems—used by EMSR and cellular telephone licensees—and high-site non-cellular systems—used by public safety, private wireless and some SMR licensees....’²²

Moreover, the 800 MHz story has a fundamentally happy ending: the source of interference was identified, and it is being removed. Consider what would have happened if the source of interference had been 50 million (unlicensed) video games. The FCC would not have gone door-to-door collecting those games; rather, public safety users would have had to live with the interference.

²² FCC, Notice of Proposed Rule Making, WT Docket 06-169 (700 MHz Guard Bands) (September 8, 2006), p. 12; quote is from *800 MHz Report and Order*, 19 FCC Rcd at 14972-73, para 2.

IV. ECONOMIC BENEFITS OF UNLICENSED ACCESS TO THE WHITE SPACE

NAF, *et al.* and the manufacturers coalition devote the bulk of their Comments to describing the economic benefits that unlicensed TV band devices would generate. These discussions are largely a recapitulation of material that has already been published, and which we addressed in our January 31 Comments. However, NAF, *et al.* make two new claims that merit a response.

Rural Broadband Access and the Tragedy of the Commons

NAF, *et al.* cite the 2006 Annual Wireless Report of the National Telecommunications Cooperative Association, which found that 61 percent of the NTCA members that responded to the survey use unlicensed spectrum to provide wireless service to their customers.²³ What NAF, *et al.* do not mention is that more than half of those respondents (52 percent) indicate that they have experienced problems with interference.²⁴ In fact, in its 2005 Annual Wireless Report, NTCA found that, by a margin of 73 percent to 27 percent, respondents indicated that they would prefer access to additional licensed spectrum over additional unlicensed spectrum.²⁵

Although NAF, *et al.* suggest that the tragedy of the commons is no more than a chimera designed to obscure the success of unlicensed spectrum, reality appears to be different. For example, Max Dearman, the CEO of Maximum Access LLC—in comments that on their face strongly support unlicensed use of the white space—asserts that the white space should not be totally unlicensed:

I am of the belief that *if this TV whitespace is allowed to be utilized as 802.11x it will soon fall in the same category [as existing unlicensed spectrum] and be considered the trash of the spectrum.* It is not uncommon to see noise floor levels as high as -70 in Monroe Louisiana as every one has a Linksys wireless router, a microwave oven, cordless telephones...etc. To turn all of these types of devices loose on such great spectrum would be an absolute shame.²⁶

That is, Mr. Dearman advocates that the TV white space should be unlicensed—but only for his uses but not for the uses—such as WiFi—that proponents of unlicensed spectrum such as the New America Foundation point to as evidence of the success of unlicensed spectrum.²⁷

²³ Comments of NAF, *et al.* in ET Docket 04-186 (February 1, 2007), p. 17.

²⁴ National Telecommunications Cooperative Association, “NTCA 2006 Wireless Survey Report” (January 2007), p. 8.

²⁵ National Telecommunications Cooperative Association, “NTCA 2005 Wireless Survey Report” (January 2006).

²⁶ Comments of Maximum Access, LLC in ET Docket 04-186, undated but received by the FCC 26 February 2007, emphasis added.

²⁷ We think that there is substantial merit in Mr. Dearman’s analysis of the merits of long-range versus short-range use of the TV white space. To the extent that the TV white space has any special characteristics, they are its long-range propagation characteristics. However, unlike Mr. Dearman, we believe that the best way to permit exploitation of the long-range characteristics of this spectrum is to license its use and to thereby enhance the incentives to invest in long-range systems.

Similarly, Mr. Dearman noted that, in South Mississippi after Katrina, establishing long-distance links was difficult, saying:

This [establishing a long-distance link] was a challenge that almost was unattainable due to the current spectrum being utilized to its fullest extent and very RF unfriendly gear being deployed in that area as well as *consumer grade devices polluting the spectrum* in Gulfport Mississippi where we were to backhaul a 45Mbps pipe to Waveland/Bay St Louis area. To make a long story short we had to abandon the 5.x spectrum and utilize a 3mbps pipe created (once again) by Trango Broadband 900 MHz radios. These radios are still in place today and still serving the people of Southern Mississippi.²⁸

Clearly, Mr. Dearman has seen the tragedy of the commons occur in relatively rural areas. As we have noted repeatedly, unlicensed spectrum is a poor home for long-distance connections. Wireless LANs impair long-distance links but long-distance links have negligible impact on wireless LAN performance. In the commons sheep that chew the grass to the ground crowd out cattle that cannot eat short grass.²⁹ Similarly, wireless LANs and cordless phones crowd out unlicensed long-distance services.

Finally, we note that some proponents of unlicensed use of the white space share our concern about the incompatibility of short-run and long-run systems. Consider the views expressed by WISPA, an industry association of wireless Internet service providers, in the current proceeding:

WISPA is opposed to any use of the Whitespaces for personal portable devices at this time. While we firmly believe that a distributed sensing model would be more than capable of protecting the broadcasters, we do NOT wish to see a spectrum issue similar to the current 2.4 GHz WiFi band. In the 2.4 GHz band channel 6 has become all but useless for large-scale, wide area deployments.³⁰

WISPA wants to reserve the commons for themselves, because ISPs recognize that their long-range systems cannot coexist with short-range systems.

Community Wireless Networking

As evidence of the value of unlicensed community wireless networks, NAF, *et al.* claim that “cellular carriers, with few exceptions, prevent their subscribers’ cell phones or PDAs from working on unlicensed networks.” The carriers are said to be fearful that unlicensed service will cut into their new and highly profitable high-speed data services, which are accessed in the places (homes, businesses and hotels) where unlicensed networks are most common. NAF, *et al.* point to the carriers’ incorporation of a crippled version of Bluetooth in their phones as the most vivid demonstration of “the economic logic driving [their] fear.”

²⁸ *Ibid.*, emphasis added.

²⁹ See <http://www.team.ars.usda.gov/grazingmanual2d.html> for a discussion of multi-species grazing and the problems created by dietary overlap among species. The suggested solution: “A common strategy to minimize this overlap, or competition, is to remove sheep from the grazing allotment.”

³⁰ WISPA Comments in ET Docket 04-186 (February 20, 2007), p. 2.

... the carriers have purposefully crippled Bluetooth to prevent customers from transferring video, audio, and other content directly to a computer or other device that would bypass their network and reduce their ability to control and charge for usage. If carriers didn't fear the great economic potential of unlicensed service, they would not have gone to such great lengths to cripple their own products.³¹

The first thing to note that the wireless industry is generally competitive: most consumers have a choice of four or more network service providers. Given this competition, we expect that the features and capabilities provided by the carriers in the portfolio of handsets they provide will reflect each carrier's estimation of the profit-maximizing mix. If consumers value Bluetooth capabilities, the carriers will provide them unless the cost of providing such capabilities exceeds what customers are willing to pay for them. Carriers have a variety of incentives to provide high-performance handsets that both complement their networks and reduce the cost of network infrastructure. The carriers have deployed three (or four, depending on how one counts) generations of network technology while preserving the use of the older technology for those consumers with older handsets.

To test the validity of NAF's assertions, we conducted a simple experiment: we attempted to transfer files between a Bluetooth-equipped wireless handset and a Bluetooth-equipped personal computer. This proved not only feasible but relatively easy to do once the computer and handset were properly set up. Specifically, we transferred a photo, an MS Word file, and a 2.74 Mbyte MP3 audio file from the handset to the computer. All three files could be opened and used on the computer. We edited the MS Word file and transferred it back to the handset and opened it in the handset.³² This personal experience provides a counter-example to NAF's general assertion that the carriers have purposefully crippled Bluetooth.³³ Maybe some carriers have done what NAF, *et al.* claim, but others clearly have not, and consumers who want to be able to use Bluetooth in this manner will migrate to the carriers that allow them to do so. In short, markets work, no less so in the case of Bluetooth file transfers.

³¹ Comments of NAF, *et al.* in ET Docket 04-186, (February 1, 2007), p. 30.

³² The handset we used contains an SD memory card. Transferring a file via Bluetooth is no more convenient just removing the SD card from the handset and inserting it into the computer's SD card slot and using the SD card as disk drive on the computer. Because we were satisfied using the SD card approach to moving files between devices, we had never bothered to try the Bluetooth transfer until we wanted to test if this handset had been "crippled."

³³ The New America Foundation's dedication to the cause of unlicensed spectrum access is not always matched by its understanding of physics and radio technology. The web site of the National Radio Astronomy Observatory contains a sidebar that pokes fun at some of the "wackier elements" in the spectrum policy debate; the sidebar consists of quotes from NAF and a pointer to the NAF website. See <http://www.cv.nrao.edu/~hlszt/RFI/RFI.htm>. No doubt the portrayal of the NAF as a "wackier element" is just the view of one scientist and not an official position of NRAO or the National Science Foundation.

APPENDIX

A Transition Plan for Wireless Microphones

The TV white space is currently used by wireless microphones. These wireless microphones are licensed under Part 74 of the rules.³⁴ Typical wireless microphones employ an FM signal in a 200 kHz channel at power levels of 10-50 mW and have a range of about 300 feet.³⁵ Wireless microphones are used in a wide variety of applications including live theater, movie production, and TV. Wireless microphones show that it is possible for additional applications to use the TV white space without creating unacceptable harmful interference to TV reception.

We believe that any plan for authorizing additional uses of the TV white space must protect existing wireless microphones for a reasonable time period and must provide a long-term home for wireless microphones. However, we also note that the technology used by wireless microphones, analog FM, is at least half a century old. Modern digital systems using lossless compression, ARQ protocols, and MIMO technologies would deliver the same quality speech but would be far more spectrum efficient. The wireless microphone industry should move to more efficient technologies just as other spectrum users have done.³⁶

We recommend the following transition plan for wireless microphones in regime in which the FCC licenses use of the white space:

Year 1: The white space licensee must establish a coordination mechanism allowing wireless microphone users to notify the white space operator of wireless microphone use. The white space licensee must protect all operations by licensed wireless microphone operators against interference provided that the wireless microphone operator has given 24 hours notice of the need to operate.

Years 2-3: The white space licensee must continue the coordination operation in place and protect all operations by licensed wireless microphone operators on *even-numbered* TV channels. Wireless microphone operators can negotiate with the white space operator for the right to operate on odd-numbered TV channels.

Year 4-6: The white space licensee must continue the coordination operation in place and must protect all operations by licensed wireless microphone operators on channels that are a *multiple of 4* (i.e., every other even numbered channel). Wireless microphone operators can negotiate with the white space operator for the right to operate on other channels.

³⁴ For further background on wireless microphones, see Comments of Shure, Incorporated in ET Docket 04-186 (January 31, 2007). Shure is a major manufacturer of wireless microphones.

³⁵ *Ibid*, at p. 4.

³⁶ We note that requiring the wireless microphone users to adopt more efficient technology is a perfect example of command-and-control regulation. However, as long as wireless microphone users have no way to benefit from improved spectrum efficiency as do the users of flexibly licensed spectrum, such command-and-control regulation appears to be the only mechanism available to push wireless microphones to adopt more spectrum-efficient technology.

Year 7: Wireless microphone operators must either employ technologies that can operate in the unlicensed spectrum at 2.4 and 5 GHz or they must negotiate operating rights with the entity holding the relevant white space license.

In addition, if the FCC chooses not to license white space operation in channels adjacent to occupied TV channels, wireless microphones can operate in the adjacent channels.

Alternate plans are possible. For example, channels 48-51 could be reserved for wireless microphone use for ten years. During that time the white space licensee would have to coordinate with wireless microphone users and protect their operations.